OSSE OBSERVATIONS OF THE GALACTIC CENTER REGION - EMISSION FROM DISCRETE SOURCES

G. V. Jung
Universities Space Research Association
300 D St. SW, Washington DC 20024

J. D. Kurfess, W. N. Johnson, M. S. Strickman, R. L. Kinzer
Naval Research Laboratory, Code 7650, Washington DC 20375-5352

W. R. Purcell, D. A. Grabelsky, M. P. Ulmer
Dept. of Physics and Astronomy, Northwestern University, Evanston, IL 60208

ABSTRACT

We present preliminary results on the X-ray emission of discrete sources in the Galactic Center region from OSSE observations made between July, 1991 and September, 1992. These observations were designed to investigate the distribution of galactic emission from the central region of our galaxy. The approach consists of scans through the Galactic Center with different position angles of the OSSE collimators' rectangular ($3.8^\circ \times 11.4^\circ$) field-of-view. The sources 1E 1740-2942, GRS 1758-258, GX 354+0, and GX 1+4, have all been observed in transient, intense states at various times during this period. A sample of these observations is presented here.

INTRODUCTION

The OSSE instrument team has undertaken a program of sensitive mapping and monitoring of the Galactic Center region to better understand the X-ray emission from the sources found there, and to determine the spatial structure and spectral character of galactic diffuse emission. The 3.8° by 11.4° (FWHM) aperture of the OSSE detectors is designed to be sensitive to diffuse emission while retaining an ability to distinguish point sources from different locations. The persistent observability of one or more of the Galactic Center sources requires special observation procedures with OSSE in order to locate X-ray sources and to extract the component spectra.

The diffuse component of galactic emission at lower energies, including the continuum associated with triplet decay of positronium, may have a centralized component in addition to the expected "ridge" emission as observed in the *HEAO A-4* survey (Peterson *et. al.*, 1990). The "mapping" mode OSSE observations, described below, are designed to distinguish a structured, diffuse emission from contributions of compact sources such as 1E 1740-2942, which lies less than a degree from the Galactic Center. In this energy range near 100 keV, OSSE is the only current instrument which can address this issue; the coded aperture instruments, such as GRIP and SIGMA(Althouse *et. al.*, 1985;Paul *et. al.*, 1991), are not sensitive to extended emission. However, observations from the SIGMA instrument are very important in the analysis of OSSE data: concurrent data collected by SIGMA can establish the spectrum of a strong compact

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source or place limits on the emission of weaker sources. Additionally, the repeated observations by SIGMA of the Galactic Center region provide an observational sampling of the sources likely to be active in any given OSSE observation of the region.

OBSERVATIONS

The observation strategy used to obtain mapping data is to obtain exposures at several angles along the OSSE scan direction in the vicinity of the Galactic Center. This procedure co-existed with the simpler experiment to monitor the central region for transient phenomena, particularly in search of variable annihilation radiation. For the monitor objective the most sensitive strategy is to 'chop' at equivalent orientations, looking for a short-term transient during a single observation, or for a long term trend, by comparing well separated observations. The phase 1 observations of the Galactic

Table 1: OSSE Galactic Center observations thru September, 1992.

Period ID	Begin Date	Duration (days)	Position angle	% off-center	remarks
5	12-Jul-1991	14	$-90°$	57%	GRS 1758-258 is on.
11	03-Oct-1991	14	$66°$	61%	GX 1+4 flares.
14	14-Nov-1991	14	$0°$	75%	4U 1700-37 in background.
16	12-Dec-1991	15	$+90°$	50%	low central continuum
17	27-Dec-1991	14	$-32°$	50%	some 4U 1700-37
21	20-Feb-1992	14	$-96°$	0%	GX 354+0 flare. Two detectors only.
24	02-Apr-1992	7	$+96°$	50%	
24.5	09-Apr-1992	7	$+93°$	50%	
25	16-Apr-1992	7	$+96°$	25%	
40	17-Sep-1992	21	$+74°$	75%	1E 1740-2942 is on. Two detectors only.

Center region, which took place between July, 1991 and September, 1992, are listed in Table 1. Significant overlap with SIGMA observations occurred during periods 11, 21, 24-25, and 40. For each of the above observations the OSSE scan plane intersects exactly with the Galactic Center, although with different orientations, expressed as position angle relative to Galactic North; angle 90 aligns the long axis of the OSSE collimator with the galactic plane $b^{\mathrm{II}} = 0$, which maximizes the response to the expected "ridge" structure of galactic diffuse radiation. The "off-center" entry in Table 1 is the fraction of the observation *not* at the galactic center position, that is, contributing to a scan in the listed orientation.

Using localization capabilities of OSSE is an important aspect of the Galactic Center observations, since source identification is an essential element for interpretation of emission spectra. Utilizing source identification and time histories from the SIGMA instrument's repeated observations greatly enhances the analysis.

SPECIFIC SOURCE OBSERVATIONS

The following figures represents a selection of data for the stronger sources with a clear identification. The data are results of different analysis methods; the 4U 1700-37 and the 1E 1740-2942 data are derived via standard background-subtracted spectra, but the spectrum for GX 1+4 is derived from the scan analysis.

The spectra shown here are still preliminary. In the treatment of multiple scan data, adequate distribution models for the diffuse emission have not yet been applied. This could be responsible for features such as the excess in the 150-200 keV region of the GX 1+4 spectrum (Figure 3). Because of the time-variable signal from 4U 1700-37 which contaminates the data of period 14, parameteric background estimation is needed in this and other portions of the scanning data; this method is established, although it is yet to be adequately verified.

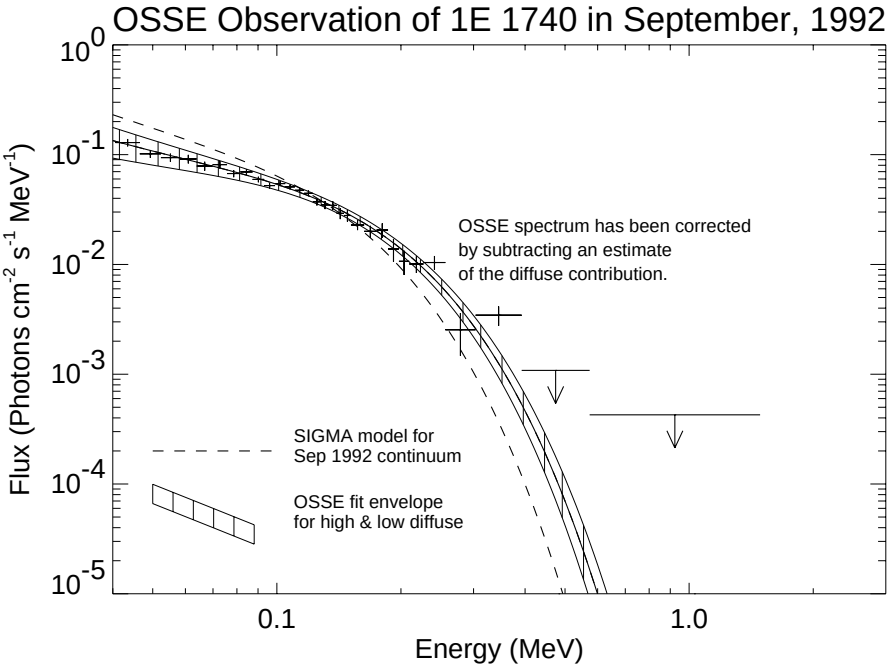

Figure 1: 1E 1740-2942 from September, 1992. This observation overlaps, in part, SIGMA observations (Cordier *et. al., 1993*), for which the reported continuum is also plotted.

1E 1740-29.42: This source is historically the strongest emitter above 50 keV in the Galactic Center region. The spectrum displayed in Figure 1 is from the observation of September, 1992. This observation is similar in procedure and orientation to the December, 1991 observation (period 16), for which the central X-ray emission was a minimum among the OSSE observations. Therefore, the period 16 spectrum was assumed to represent only galactic diffuse emission. Using a model-dependent scaling in a simplified analysis, this spectrum was used to correct for the diffuse contribution to the September 1992 (Figure 1). The resulting spectrum is well above the correction applied; the envelope about the fitted model encompasses a range of results due to different assumptions of distribution models.

The September 1992 observation was the highest intensity thus far recorded by

OSSE for 1E 1740-29.42, which had been in a state of generally low intensity. The lower-intensity period will help in the analysis of the diffuse galactic emission near the center.

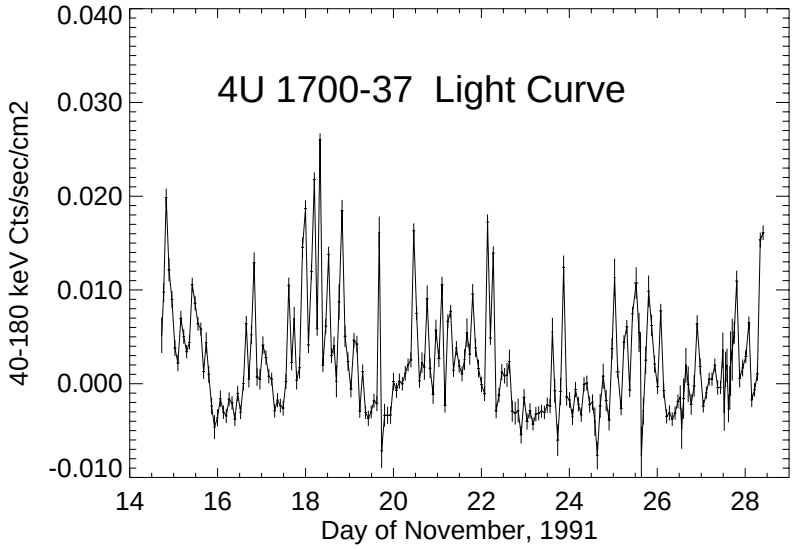

Figure 2. **4U 1700-37** November, 1991

4U 1700-37: This is an eclipsing X-ray binary, believed to be powered by accretion from the companion's stellar wind. Figure 2 shows a light curve of this source from the November, 1991 observations; it was viewed by each detector in one half of the background exposures. The lowest rate of the light curve is slightly negative because the Galactic Center exposures are subtracted for background estimation.

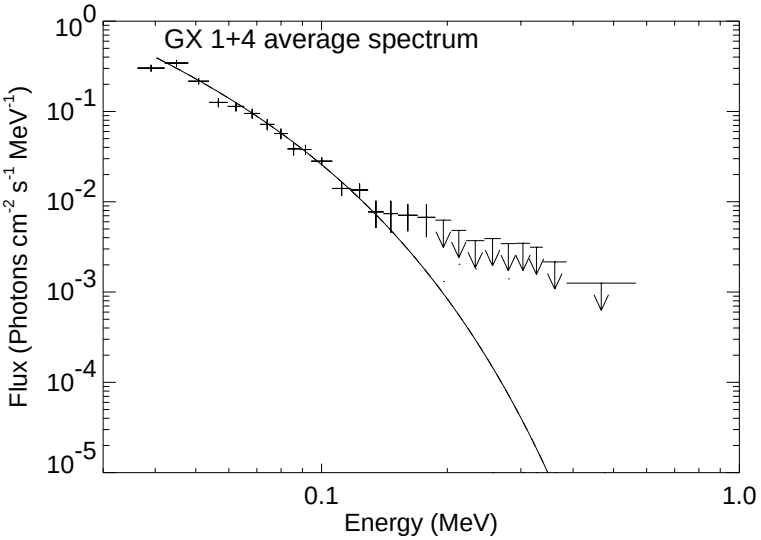

Figure 3. **GX 1+4** Average Spectrum

GX 1+4: This high-mass X-ray binary flared during the October, 1991 observation. Excluding this period, the OSSE observations indicate a persistent emitter at this location. The model plotted in Figure 3 is optically thin thermal brehmstrahlung emission with kT $\approx$ 40 keV. Systematic errors have not been evaluated, and the apparent excesses above 100 keV might result from incorrectly modelling the distribution of diffuse emission.

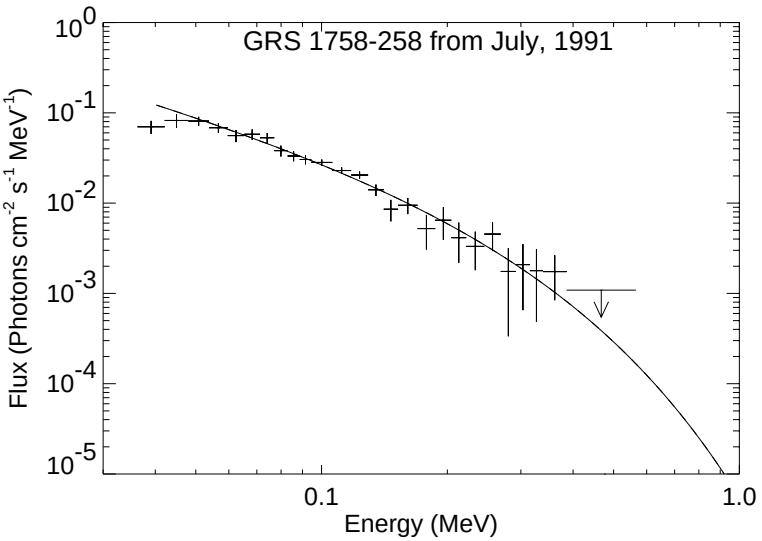

Figure 4. **GRS 1758-258** July, 1991

GRS 1758-258: This source was active during the OSSE observations of the galactic center in July, 1991. SIGMA observations in fall of 1991 did not detect this source, nor is it evident in successive OSSE scans. The model plotted in Figure 4 is an optically thin thermal brehmstrahlung emission with kT $\approx$ 150 keV.

SUMMARY

The OSSE observations of the Galactic Center region are unique in their sensitivity to both diffuse and compact sources of emission. The goal of this analysis is to determine the spectra and time histories of the discrete sources in the Galactic Center region and to map the diffuse emission. Despite the source confusion inherent in this data, high quality spectra can be obtained for the intense episodes of the variable sources and for the time-averaged emission of other persistent sources in the region.

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